NAVFAC
Naval Facilities Engineering Command
ENGINEERING SERVICE CENTER

# Navy Expeditionary Technology Transfer Program (NETTP)

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# Brief Contents

- Expeditionary energy consumption problem
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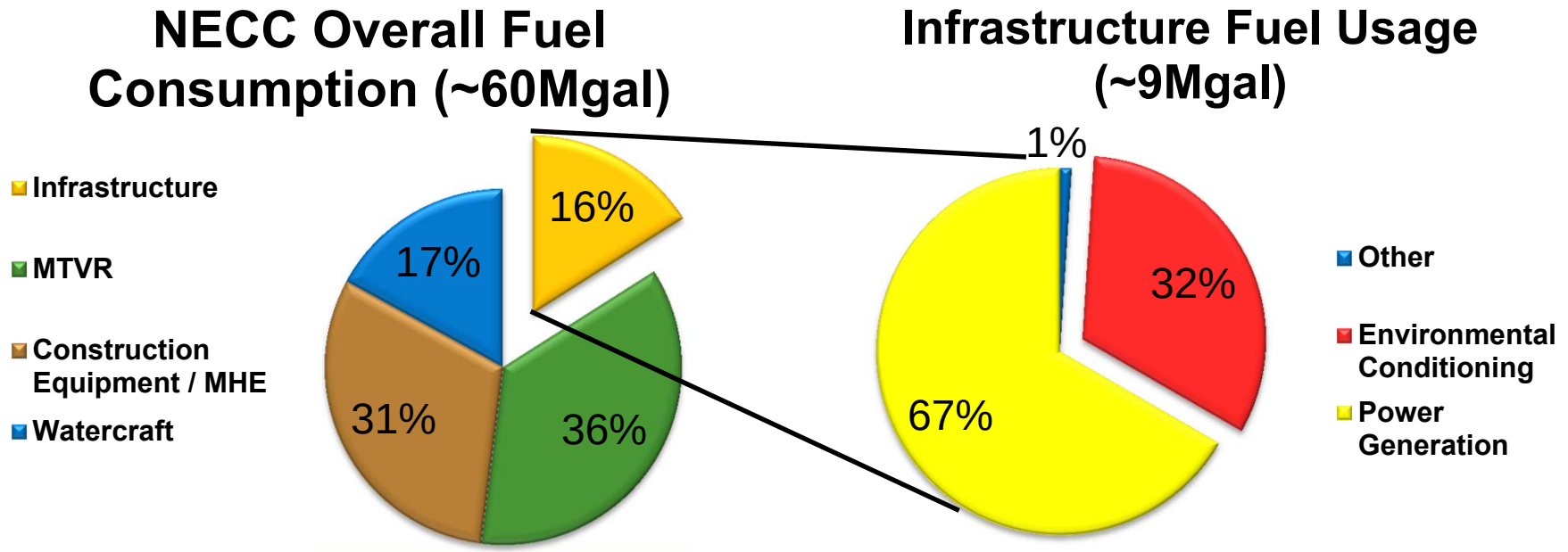
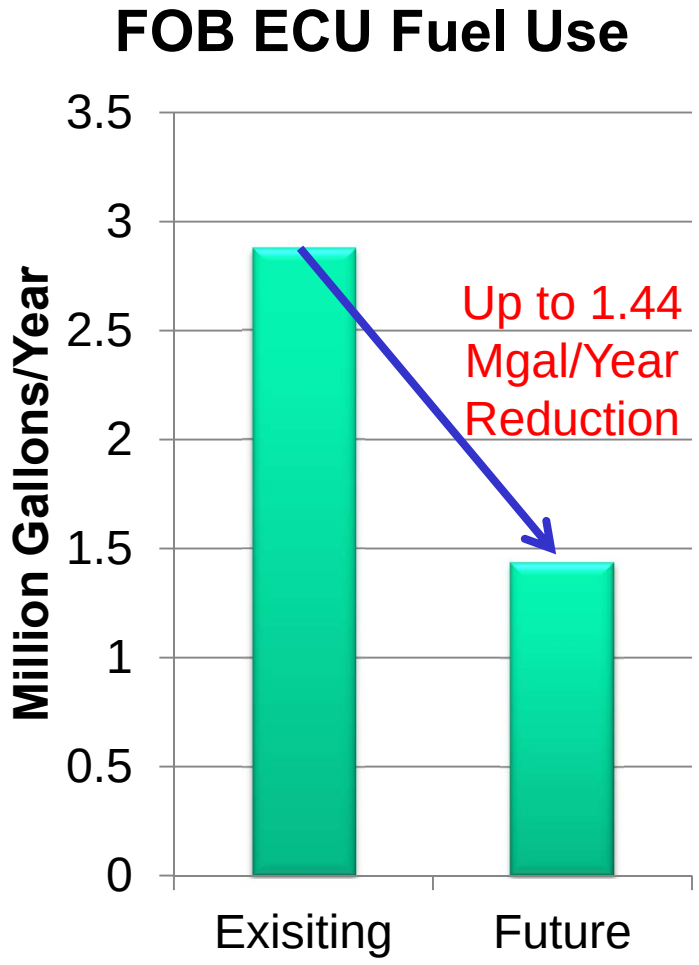
# Expeditionary Energy Consumption

- Deployed Navy Expeditionary Forces use up to 9 Mgal/yr for infrastructure related fuel usage
- Environmental Conditioning accounts for ~ 32% of FOB energy used
- Fuel accounts for ~ 50% of logistics convoy loads
- 1 soldier is killed or wounded for every 24 fuel convoys
- ECU operations cost ~ $43 M/yr at a $15/gal Fully Burdened Cost of Fuel

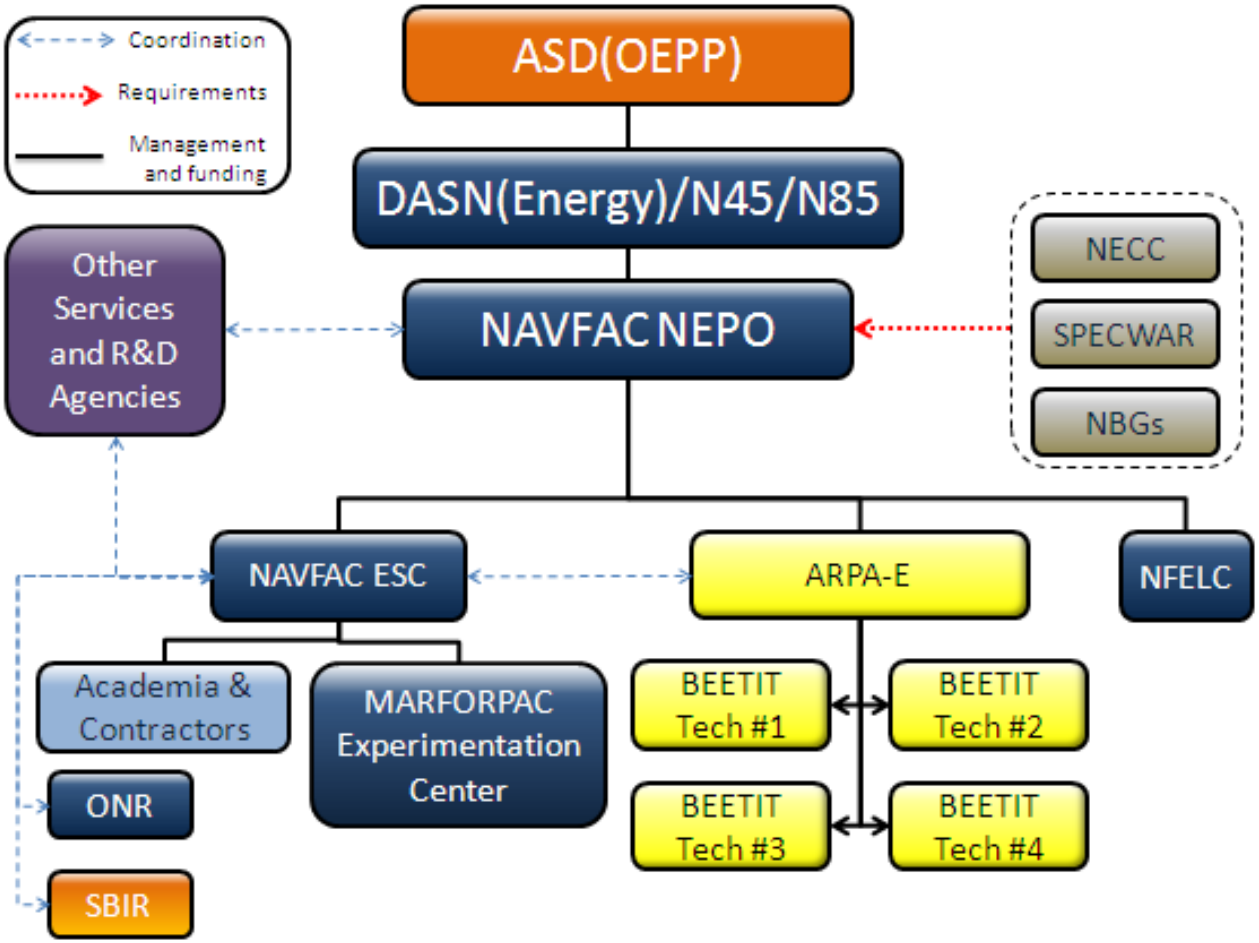


# Expeditionary ECU Goals

- **NETTP goal is to develop advanced ECUs**
  - **1.25-2x improved efficiency**
  - **Rated for expeditionary environments**
  - **Fit within the size and weight envelope of current systems**
  - **Cause no increase in logistics support**

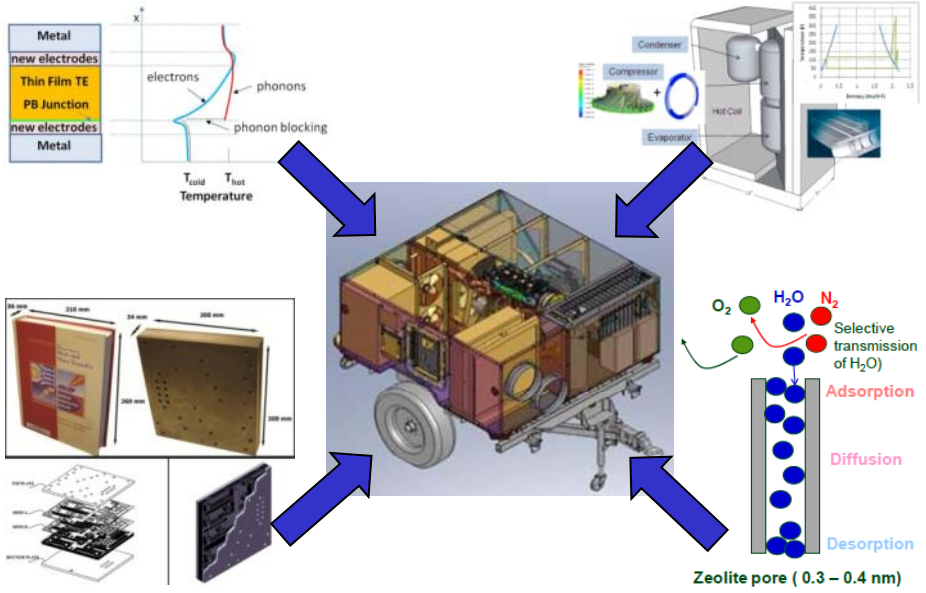


# NETTP Program Structure



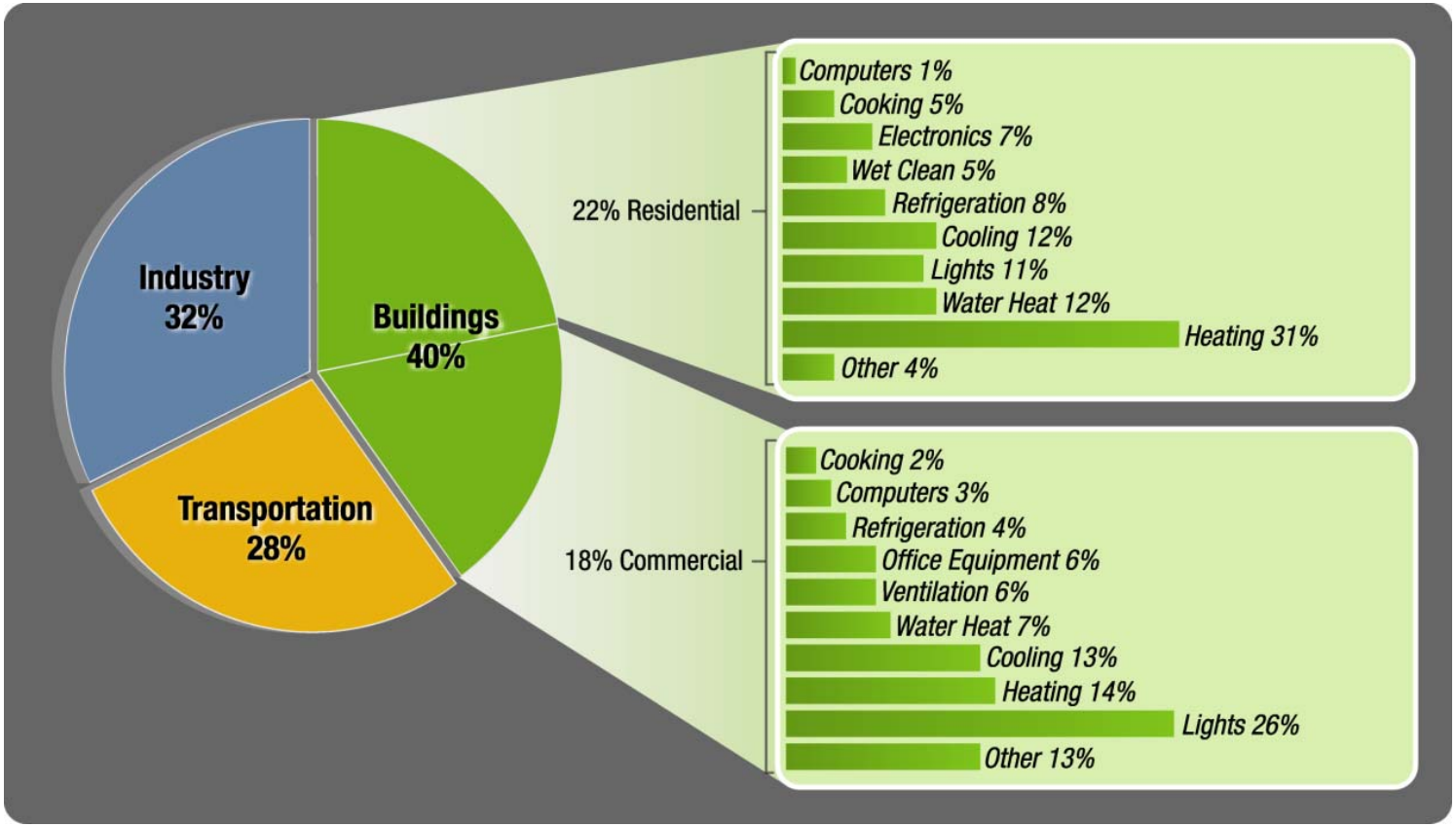
# NETTP Approach

- **Leverage the R&D efforts of the DOE Advanced Research Projects Agency–Energy (ARPA-E) in the area of efficient heating and cooling technologies**
- **NETTP will expand existing research efforts in the ARPA-E portfolio to focus on expeditionary ECUs**
- **Currently identified candidate technologies**
  - **–Membrane Dehumidification**
  - **–Absorption Cooling**
  - **–Thermoelectric Cooling**
  - **–Water-based HVAC**



# The ARPA-E BEETIT Program

- **BEETIT: Building Energy Efficiency Through Innovative Thermodevices**
- **Buildings use 72% of electricity and 55% of the natural gas in the U.S.**
- **Heating & cooling account for ~ 50% of energy consumption**

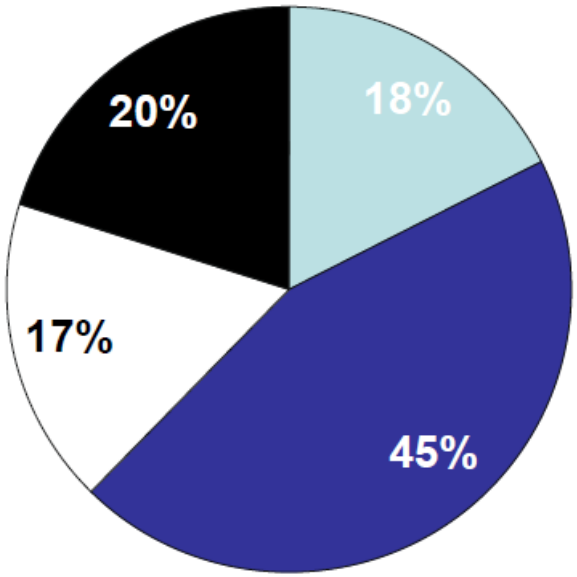



Source: LBNL Environmental Energy Technologies Division, 2009

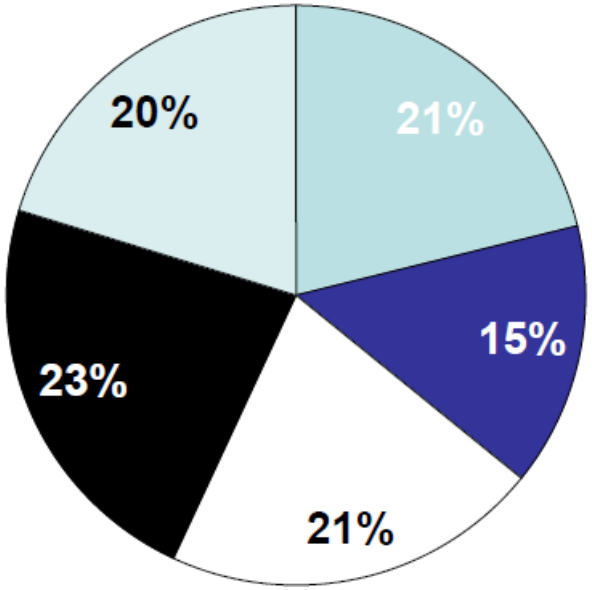
# BEETIT Portfolio Breakdown

- **$30.3 M, 3 years, 16 projects**

Seedling
(<$1 M)



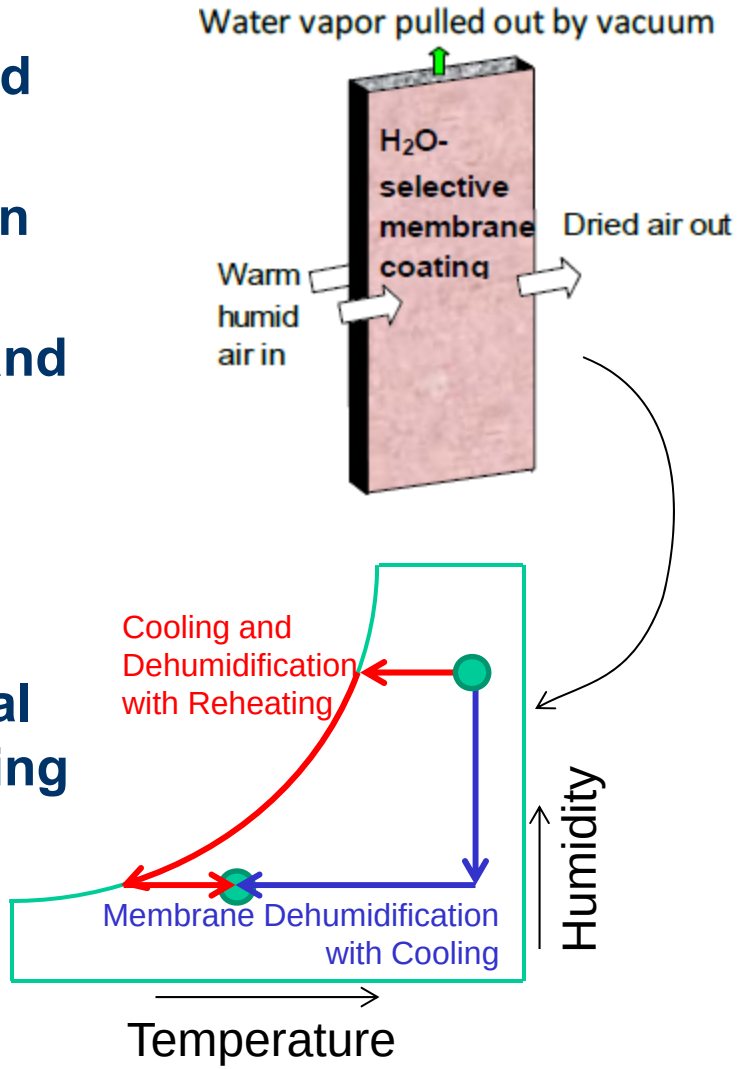

Advanced Device Prototyping
($3-4 M)




- Vapor Absorbtion/Adsorbtion
- Solid State Cooling
- Gas Cycles
- Dehumidification
- Mechanical Vapor Compression

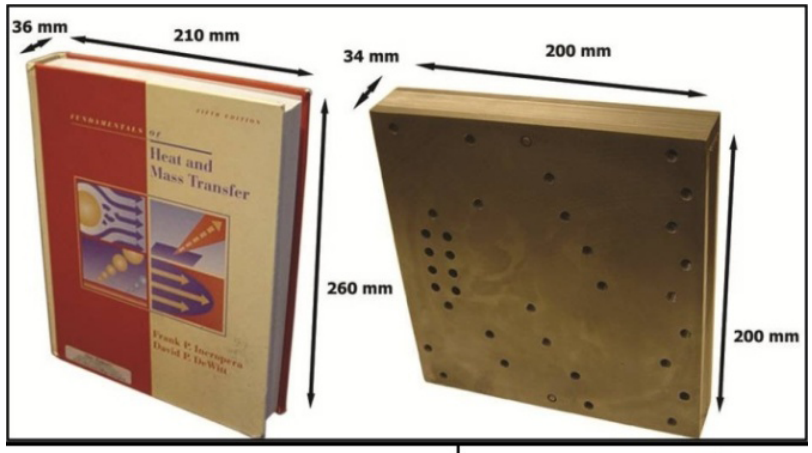
# Membrane Dehumidification

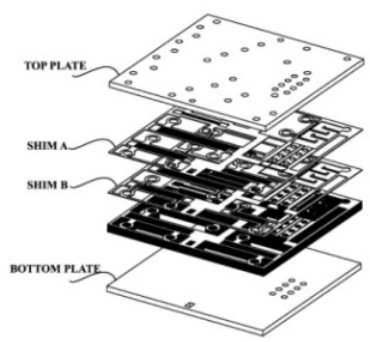
- Selective removal of water vapor from feed air using a zeolite membrane
- Temperature/Humidity levels can be met in warm, humid climates without reheating
- Allows higher cooling coil temperatures and a higher Coefficient of Performance
- Can be used as a drop-in solution for retrofitting\ of existing AC systems
- Possible to achieve $(COP)_{Th}$ of >1.12 for cooling of hot, humid air with conventional vapor compression AC systems by avoiding latent cooling duty with the membrane dehumidification

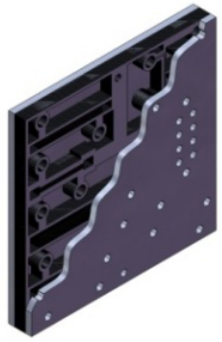


# Modular Thermal Hub

- Small, efficient absorption cooling
- Energy source: Combustion, low-grade waste heat, solar thermal energy
- Reversible operation enables space cooling and heating, and water heating
- Modular cooling and heating unit
- Monolithic packaging offers small fluid charge, flexible placement
- Working fluid with zero GWP
- Long-term equivalent electric COPs: 2.5–8.3

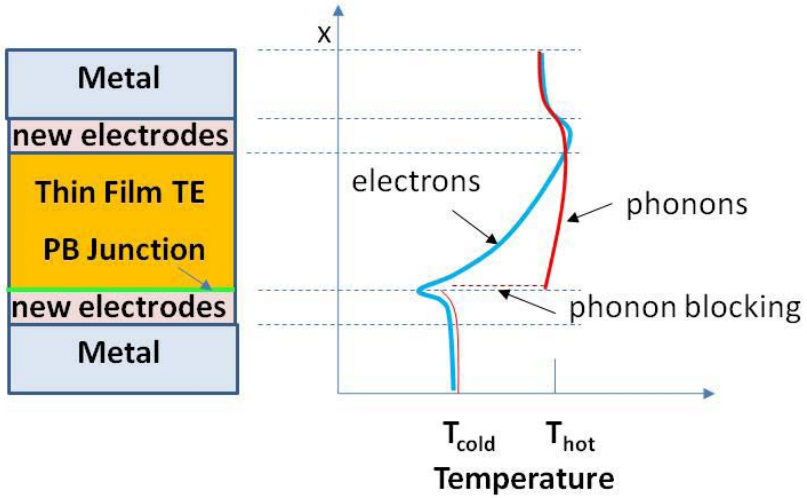


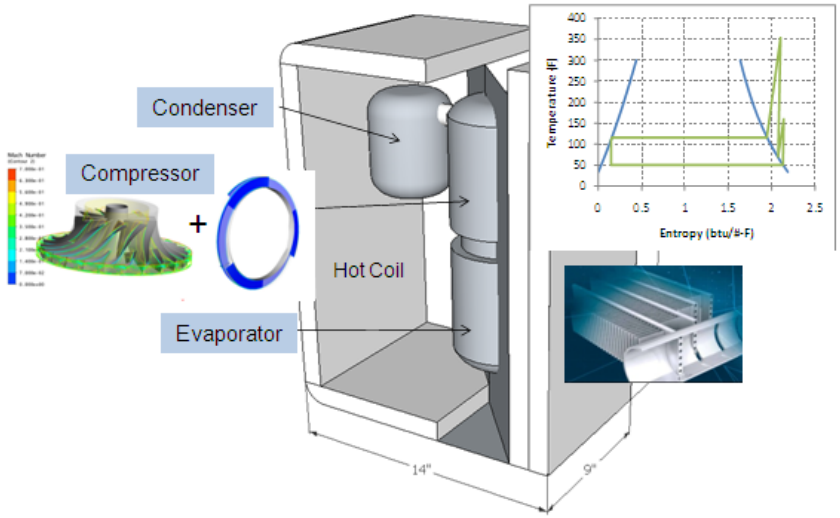
# Non-Equilibrium Asymmetric Thermoelectrics

- **NEAT will result in light, reliable, low-cost, green cooling engines with no moving parts**
- **NEAT may attain COP>4 at ΔT=22°C (vs COP <2 for current TE)**
- **Mitigation of interface losses in thin film coolers using novel electrodes**
- **Non-equilibrium effects utilized to decouple electron and phonon systems in thin films**



# Water based HVAC System

- **Utilizes water as the refrigerant with a goal COP>4**
- **Enables use of water as a cost-effective, zero global warming potential non-flammable and non-toxic option for air-conditioning and refrigeration devices**
- **Supersonic compression enables single-stage high compression**



# Contact Information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